SOUND

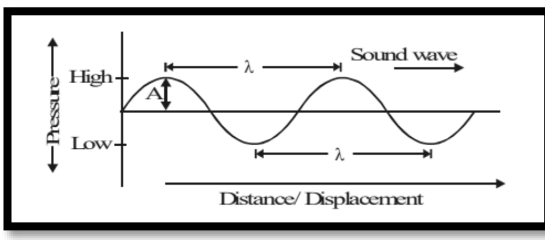
CHARACTERISTICS OF SOUND WAVE

Sound waves are longitudinal waves

When a sound wave travels through the material medium, then compressions and rarefactions follow one another. The particles of the medium through which a sound wave travels vibrate to and fro about their mean positions parallel to the direction of propagation of the sound wave. Since the wave is known as longitudinal wave, if the particles of the medium vibrate to and fro about their mean positions parallel to the direction of propagation of the wave, therefore, the sound waves are longitudinal waves.

Characteristics of a sound wave

When a sound wave travels through a material medium, then the density or pressure of the medium changes continuously from maximum value to minimum value and vice-versa. Thus, the sound wave propagating in a medium can be represented as shown in figure.



Now, we shall discuss the characteristics or quantities to describe a sound wave

(i) Amplitude:

The maximum displacement of a vibrating body or particle from its rest position (i.e., mean position) is called amplitude.

(ii) Wavelength (or length of a wave):

The distance between two successive 1 regions of high pressure or high density (or compressions) or the distance between two successive regions of low pressure or low density (or rarefactions) is known as wavelength of a sound wave. It is denoted by λ (read as lambda). In S.I., unit of wavelength is meter (m).

(iii) Frequency:

The number of oscillations or vibrations made by a vibrating body or particles of a medium in one second is known as the frequency of a wave. It is denoted by υ (read as Neu). In S.I., unit of frequency is hertz (Hz). 1 hertz = one oscillation completed by a vibrating body or a vibrating particle in one second.

(iv) Time period:

Time taken by a vibrating particle or a body to complete one vibration or oscillation is known as time period. It is denoted by T. In S.I., unit of time period is second(s). Relation between Frequency and time period Let T = time period of a vibrating body. Then number of oscillations completed in T second = 1

$\therefore$ number of oscillations completed in 1 second = $\frac{1}{T}$

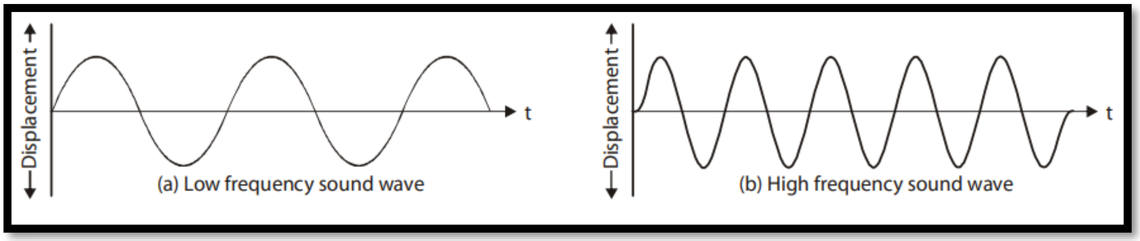
But number of oscillations completed in 1 second = frequency (v)

$\therefore$ (f) $v = \frac{1}{T}$, $frequency = \frac{1}{Time\ period}$

(iv) Pitch or Shrillness:

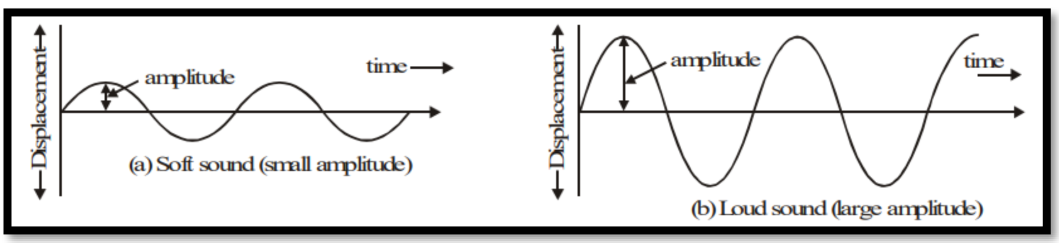
Pitch is the characteristic (i.e., typical feature) of a sound that depends on the frequency received by a human ear.

A sound wave of high frequency has high pitch and a sound wave of low frequency has a low pitch. You must have noticed that the voice of a woman has higher pitch than the voice of a man. Thus, the frequency of woman's voice is higher than the frequency of man's voice. A sound wave of low pitch (i.e. low frequency) is represented by figure (a) and a sound wave of high pitch (i.e. high frequency) is represented by figure (b)



(v) Loudness:

Loudness of a sound depends on the amplitude of the vibrating body producing the sound. A sound produced by a body vibrating with large amplitude is a loud sound. On the other hand, a sound produced by a body vibrating with small amplitude is a feeble or soft sound. Loud sound and soft or feeble sound are represented as shown in Figure (a) and (b) respectively.

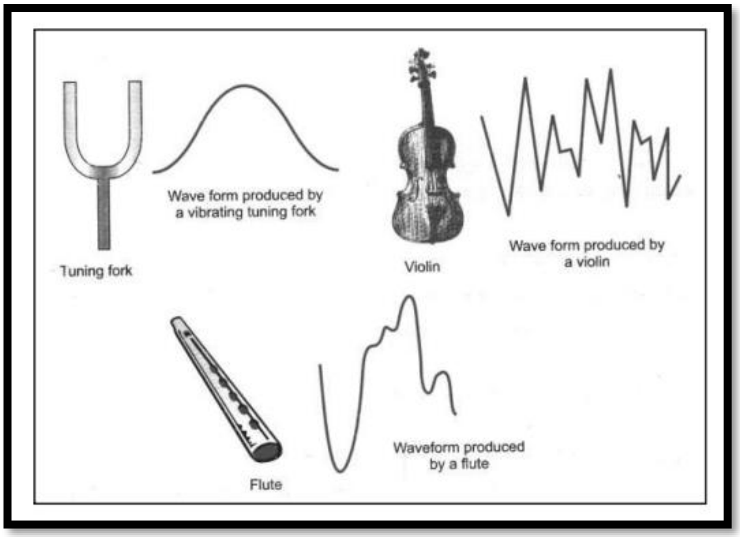


Loudness is a subjective quantity :

It depends on the sensitivity or the response of our ears. A loud sound to a person may be a feeble sound for another person who is hard of hearing.

(vi) Timbre or quality:

Quality or timbre is a characteristic (i.e., a typical feature) of a sound which enables us to distinguish between the sounds of same loudness and pitch. This characteristic of sound helps us to recognize our friend from his voice without seeing him. The quality of two sounds of same loudness and pitch produced by two different sources are distinguishable because of different waveforms produced by them. The waveforms produced by a vibrating tuning fork, violin and flute (Bansuri) are shown in figure



(vii) Intensity:

Intensity of a sound is defined as the sound energy transferred per unit time through a unit area placed perpendicular to the direction of the propagation of sound.

That is, $$intensity\ of\ \ sound = \frac{Soundenergy}{Time \times Area}$$

Intensity of a sound is **an objective physical quantity.** It does not depend on the response of our ears.

In S.I., unit of intensity of sound is joule s^{-1} m^{-2} or watt m–2 ($1Js^{-1} = 1W$)